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Endogenous Growth and Equilibrium Unemployment in a North–South Model

*Hian Teck Hoon**

Abstract

A North–South model is developed which incorporates an endogenous rate of equilibrium unemployment in the North in the context of long-run growth. It is shown how increases in the size of public debt and unemployment compensation financed by payroll taxation, all measured relative to productivity, raise the Northern natural rate of unemployment and, consequently, reduce the global rate of long-run growth. The effect of the shocks is also to drive down the rate of employment expansion in the South. A set of the fundamental determinants of the world terms of trade is obtained, which includes policy parameters.

1. Introduction

Over the past two and a half decades, the growth rates of many of the OECD countries, particularly in western Europe, have declined compared with the 1950s and 1960s, while there has been a sharp rise in the equilibrium rate of unemployment. This paper attempts to build a model in which both the equilibrium unemployment rate in the North and long-run growth are derived endogenously. It demonstrates how economic shocks drive the equilibrium rate of unemployment, and consequently affect growth rates in the global economy. In particular, I am interested in studying the effect of an increase in the size of the public debt as well as an increase in unemployment benefits financed by payroll taxation (all measured relative to productivity) in the North. I show that the effect of the policy shocks is to raise the amount of joblessness in the North, which, via an adverse effect on the return to capital, slows the pace of capital accumulation. Through a learning-by-doing link, this leads to a slowdown in Northern growth, and ultimately in Southern growth via a terms-of-trade deterioration facing the South.

The work reported here is related to Findlay (1980) and Taylor (1981) but is clearly distinct from them in the theoretical specification of the important mechanisms describing the Northern economy. In Findlay (1980), the Northern economy is a full-information, neoclassical economy with full employment always prevailing. In the North developed here, the labor market is characterized by the problem of imperfect information with labor shirking and costly supervision, and consequently endogenous job rationing. A form of real-wage rigidity is endogenously derived so that, even in a consistent-expectations equilibrium, there exists involuntary unemployment. In contrast, Taylor (1981) specifies a Northern economy faced with nominal wage rigidity, with the consequence of short-term Keynesian unemployment or expectational

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disequilibrium unemployment of the Phillips-curve type. The South is, nevertheless, specified in the same manner as in the two aforementioned papers; namely, a Lewis-type labor-surplus economy.

In section 2, I develop the basic model of the world economy exhibiting balanced growth. Section 3 studies the effect of increased public debt holdings and increased unemployment compensation, both financed by payroll taxation. Section 4 concludes.

2. The Balanced-Growth Model

In this section, I study the properties of a model with zero debt and unemployment benefit, characterized by balanced growth in the North. Assuming that a version of the Marshall–Lerner condition is satisfied, I show that the growth rate of the South converges to the Northern balanced growth rate. In the following section, I will then examine the effect of policy shocks.

Production Conditions in the North

Production and investment are carried out by many identical competitive firms. Additionally each firm faces a nonclassical labor market where each worker is prone to shirk. In this setting each of the many identical, atomistic firms seeks a wage policy to maximize its profits. The single Solow good produced in the North is given by $Y^N = F(K^N, \varepsilon \Lambda^N N^N)$, where Y^N is defined as output, K^N is the capital stock, ε is the effort function to be defined later, Λ^N is a measure of Harrod-neutral technical progress to be endogenized later, and N^N is the number of employed workers in the Northern economy. It is assumed that the $F(\cdot)$ function is homogeneous of degree one in its two arguments. By virtue of this, we can write $Y^N = \Lambda^N L^N F(K^N/(\Lambda^N L^N), \varepsilon N^N/L^N)$, where L^N is the size of the labor force. Thus the unemployment rate is $(L^N - N^N)/L^N$ and denoted U^N . If, for simplicity, we normalize the labor force to unity, we may write $N^N \equiv 1 - U^N$. The problem solved by the representative Northern firm at each point in time is given by

$$\max \quad \Lambda^N \{F(k^N, \varepsilon[1 - U^N]) - r^N k^N\} - v^N [1 - U^N],$$

where we let $k^N \equiv K^N/\Lambda^N$, r^N is the real interest rate in the North, and v^N is the Northern real wage.

The function $F(k^N, \varepsilon[1 - U^N])$ satisfies the following properties: $F_1, F_2 > 0$, $F_{11}, F_{22} < 0$, and $F_{11}F_{22} - F_{12}^2 = 0$. Note that, with the assumption of linear homogeneity of the production function at the level of the atomistic firm, we can write $F(k^N, \varepsilon[1 - U^N]) = k^N F_1(k^N, \varepsilon[1 - U^N]) + \varepsilon[1 - U^N] F_2(k^N, \varepsilon[1 - U^N])$. It follows, by differentiation, that $F_{12}(k^N, \varepsilon[1 - U^N]) = -\varepsilon[1 - U^N] F_{22}(k^N, \varepsilon[1 - U^N])/k^N > 0$; that is, capital and labor services are complements in the Edgeworth–Pareto sense. This feature of the model will provide us a positive link between the rate of employment and the marginal productivity of capital.

In the production function, we multiply each unit of labor by an index of the level of efficiency or effort function, ε . The effort function, ε , identical across all workers and faced by any firm, will be written as a function of the real wage received by the worker hired at the firm, v^N ; an indicator, z^N , of the expected value of net wage earnings for a worker who loses his job at the firm; the average expected nonwage income of workers—to be more precise, the average income from wealth, y^{wN} . Here, z^N gives the

income prospects obtainable in the rest of the economy faced by a worker who loses his job at the firm where he is currently employed. A plausible specification of the effort function is that it depends upon the expected nonwage income of the employees relative to their take-home real wage, y^{wN}/v^N , and the prospective real net wage earnings obtainable elsewhere relative to the take-home pay earned by the worker at the firm, z^N/v^N (Hoon and Phelps, 1992; Phelps, 1994). By incorporating a wealth effect in the shirking propensity, we allow for a sustained productivity growth along with a nonvanishing equilibrium rate of unemployment. The intuition behind the role played by wealth in avoiding a vanishing natural rate of unemployment in the process of growth is the following. As workers become wealthier, the incentive wage that firms are required to pay to combat shirking rises. As the incentive wage or supply wage rises along with the demand wage, the latter driven by higher productivity, we are able to avoid a secular decline in equilibrium unemployment.

We write the effort function as $\varepsilon(z^N/v^N, y^{wN}/v^N)$ with the properties $\partial\varepsilon/\partial[z^N/v_h^N] \equiv \varepsilon_1 < 0$ and $\partial\varepsilon/\partial[y^{wN}/v^N] \equiv \varepsilon_2 < 0$. We further assume that $\varepsilon_{11} < 0$ and $\varepsilon_{22} < 0$ by virtue of the firm's second-order condition. In addition, we make the reasonable assumption that an increase in nonwage income raises a worker's marginal propensity to shirk with respect to wage prospects elsewhere; that is, $-\varepsilon_{12} > 0$. Employees are, therefore, more likely to shirk when job prospects elsewhere improve relative to the net wage they currently receive; an increase in their expected nonwage income relative to their current take-home pay also raises the shirking propensity.

Our first-order necessary conditions (which are also sufficient under our assumptions) are given by

$$\varepsilon F_2(k^N, \varepsilon[1 - U^N]) = \frac{v^N}{\Lambda^N}; \quad (1)$$

$$-F_2(k^N, \varepsilon[1 - U^N]) \left\{ \varepsilon_1 \left[\frac{z^N}{v^N} \right] + \varepsilon_2 \left[\frac{y^{wN}}{v^N} \right] \right\} = \frac{v^N}{\Lambda^N}; \quad (2)$$

$$F_1(k^N, \varepsilon[1 - U^N]) = r^N. \quad (3)$$

Equation (1) gives us the firm's real demand wage by equating the real wage, v^N , to the marginal product of employing an additional worker, $\varepsilon \Lambda^N F_2(k^N, \varepsilon[1 - U^N])$. Equation (2) gives the real supply wage the firm has to choose to induce optimal effort from its workforce. It is obtained after simplifying the following expression:

$$-\Lambda^N F_2 \left[\frac{\varepsilon_1 z^N}{v^{N2}} + \frac{\varepsilon_2 y^{wN}}{v^{N2}} \right] = 1.$$

The addition to the annual cost per worker of motivating its workforce by raising a penny is one. The benefit per worker of doing so is the contribution to total product per worker brought about by the higher effort induced. Equating these, and rearranging, gives (2). Finally, (3) equates the real interest rate to the private marginal product of capital.

Utility Maximization by Northern Consumer-Workers

I will assume that the worker's period utility function is Cobb–Douglas in the consumption of the Solow manufactured good, C_m^N , as well as the Southern agricultural good, C_a^N ;

that is, the Northern worker's period utility function is given by $C_m^{\beta} C_a^{N[1-\beta]}$, $0 < \beta < 1$. Defining $E^N \equiv \theta C_a^N + C_m^N$ as the total consumption expenditure of the worker, where θ is the relative price of agriculture in terms of manufactures, the assumption of Millian period utility function implies $\theta C_a^N = (1 - \beta)E^N$ and $C_m^N = \beta E^N$. I incorporate the Blanchard–Yaari overlapping-generations model with a constant labor force (normalized to one). Each agent is assumed to be a supplier to the labor market; and, to avoid the considerations of risk, I assume that each agent is a unified household with a large number of members suffering the same unemployment rate as the population as a whole. As in Blanchard (1985), the critical equation describing the law of motion of per capita aggregate consumption (measured in terms of the Solow good) is given by

$$\frac{\dot{E}^N}{E^N} = [r^N - \rho] - \mu[\mu + \rho] \frac{A^N}{E^N}, \quad (4)$$

where E^N is per capita aggregate consumption expenditure, ρ is the rate of time preference, μ is the constant probability of death, and A^N is the nonhuman wealth per worker. (I will more clearly define what is included in A^N later.) In the next subsection I turn to solving the general equilibrium of the Northern economy.

General-Equilibrium Conditions in the North

Equations (1) to (3) summarize the conditions that have to be satisfied for the typical firm. Using the Salop–Calvo indicator (Salop, 1979; Calvo, 1979):

$$z^N = (1 - U^N)v^N, \quad (5)$$

where z^N is taken to be the wage expected elsewhere adjusted for the probability of obtaining a job, we note that the effort function, in general equilibrium, is a function of the rate of employment as well as the nonwage income relative to the real wage; that is, we can write the effort function as $\varepsilon(1 - U^N, y^{wN}/v^N)$. To be more precise, we need to define the sources of expected nonwage income. In the basic model, without any policy interventions, nonhuman wealth, A^N , is simply given by K^N . Hence I will write $y^{wN} \equiv (r^N + \mu)K^N$, where $(r^N + \mu)$ is the rate of return inclusive of the actuarial component arising from the use of the Blanchard–Yaari framework. The expected nonwage income relative to the wage can be expressed as $y^{wN}/v^N \equiv (r^N + \mu)K^N/v^N$. Using (1) and (3), we can express the nonwage income to wage ratio as

$$\frac{y^{wN}}{v^N} \equiv \frac{F_1(k^N, \varepsilon[1 - U^N])k^N}{\varepsilon F_2(k^N, \varepsilon[1 - U^N])} + \frac{\mu k^N}{\varepsilon F_2(k^N, \varepsilon[1 - U^N])}. \quad (6)$$

Let us be more precise about the behavior of the level of technical progress. Using a learning-by-doing assumption about technical progress in the spirit of Arrow (1962), let $\Lambda^N = \Lambda(K^N)$; that is, the measure of workers' productivity depends upon the experience derived from capital accumulation. I use here a simple formulation which assumes that

$$\Lambda^N = \frac{K^N}{a}, \quad (7)$$

where a is a positive constant. It then follows that $k^N = a$, a constant. Using this fact in (6), we have

$$\frac{y^{wN}}{v^N} \equiv \frac{F_1(a, \varepsilon[1-U^N])a}{\varepsilon F_2(a, \varepsilon[1-U^N])} + \frac{\mu a}{\varepsilon F_2(a, \varepsilon[1-U^N])}. \quad (8)$$

Note that in (8), under general-equilibrium conditions, the two arguments in the effort function are $1 - U^N$ and y^{wN}/v^N , respectively. Also note that by equating the general-equilibrium versions of the real demand wage in (1) to the real supply wage in (2), we obtain the generalized Solow elasticity condition:

$$-\left[(1-U^N)\frac{\varepsilon_1}{\varepsilon} + \left(\frac{y^{wN}}{v^N}\right)\frac{\varepsilon_2}{\varepsilon}\right] = 1, \quad (9)$$

which equates the sum of the partial elasticities to unity. It follows from (9) that around an equilibrium, $0 < -(1 - U^N)\varepsilon_1/\varepsilon < 1$ and $0 < -(y^{wN}/v^N)\varepsilon_2/\varepsilon < 1$.

From (3), we also obtain an expression for the real interest rate in general equilibrium:

$$r^N = F_1(a, \varepsilon[1-U^N]), \quad (10)$$

which shows that the interest rate is equated to the marginal productivity of capital. Suppose that the economy's unemployment rate rises from 3% to 10%, roughly the order of magnitude that occurred in various OECD countries, especially western Europe, over the past two and a half decades. The massive increase in idleness resulting from the large inflow into the pool of unemployment has a direct depressing effect on the marginal productivity of capital as labor and capital are Edgeworth–Pareto complements. This is the direct effect of increased joblessness on capital productivity. There is, however, an indirect attenuating effect that is at work in this model. As currently employed workers find the probability of obtaining employment elsewhere is reduced, they value their jobs more and are induced to work harder. This acts to offset the direct negative effect. If we proceed with the assumption that the direct effect dominates, a condition given by $J \equiv \varepsilon + (1 - U^N)\{\varepsilon_1 + \varepsilon_2[\partial(y^{wN}/v^N)/\partial(1 - U^N)]\} > 0$, we obtain the result that a rise in the equilibrium rate of unemployment—that is, a decrease of $1 - U^N$ —leads to a decline in r^N as the marginal productivity of capital is reduced as a result of increased joblessness. The dynamic equation of motion of real consumption expenditure in the North is

$$\frac{\dot{E}^N}{E^N} = [F_1(a, \varepsilon[1-U^N]) - \rho] - \mu[\mu + \rho]\left[\frac{a}{E^N/\Lambda^N}\right]. \quad (11)$$

I now wish to establish that a balanced growth path exists along which output, capital, and consumption expenditure all grow at the rate of productivity growth, $\lambda^N \equiv \dot{\Lambda}^N/\Lambda^N$. Firstly, note that with $k^N = a$, it follows that $\dot{K}^N/K^N = \lambda^N$. It is straightforward to check from (8) and (9) that given our specification of technology generation in (7), we obtain constant $1 - U^N$ and y^{wN}/v^N . With $1 - U^N$ and y^{wN}/v^N constant as K^N and Λ^N grow at λ^N , it follows that, since $Y^N/\Lambda^N = F(a, \varepsilon[1 - U^N])$, we have that $\dot{Y}^N/Y^N = \lambda^N$. Assuming that there is no international capital mobility as in Findlay (1980), we have the relationship $Y^N = E^N + \dot{K}^N$. Replacing Y^N by the production function, it is easy to check that $E^N/\Lambda^N = F(a, \varepsilon[1 - U^N]) - \lambda^N a$. Then given λ^N , E^N/Λ^N is constant. Hence $\dot{E}^N/E^N = \lambda^N$. From (11), we therefore obtain an expression for the endogenous long-run growth rate of the Northern economy, λ^N :

$$\lambda^N = [F_1(a, \varepsilon[1 - U^N]) - \rho] - \mu[\mu + \rho] \left[\frac{a}{F(a, \varepsilon[1 - U^N]) - \lambda^N a} \right]. \quad (12)$$

The right-hand side of (12) is a decreasing function of λ^N , so the equilibrium value of λ^N is uniquely determined. Noting that $s^N Y^N = \dot{K}^N$, we have an expression for the savings rate of the North, s^N :

$$s^N = \left[\frac{\dot{K}^N}{K^N} \right] \left[\frac{K^N / \Lambda^N}{Y^N / \Lambda^N} \right] = \frac{a \lambda^N}{F(a, \varepsilon[1 - U^N])}, \quad (13)$$

where λ^N is implicitly given by (12).

General-Equilibrium Conditions in the South

The South produces a single good, an agricultural good. Let Y^S be the output of agriculture in the Southern economy. Its constant-returns-to-scale production function is expressed as $Y^S = G(K^S, N^S)$, where K^S is the capital stock used in the South in the modern agricultural sector and N^S is the number of employed Southern workers. It is convenient to express the output in the South as $Y^S = N^S G(K^S / N^S, 1) = N^S g(k^S)$, where $k^S \equiv K^S / N^S$. As in Findlay (1980), we assume that there is surplus labor in the rest of the economy à la Arthur Lewis. At an exogenously given real wage expressed in terms of agriculture, there is an infinitely elastic supply of labor to the modern agricultural sector. Profit maximization in the modern agricultural sector gives rise to

$$\bar{v}^S = g(k^S) - k^S g'(k^S), \quad (14)$$

where \bar{v}^S is the rigid real wage measured in terms of the agricultural good.

With the real wage being rigid, the capital-labor ratio employed in the agricultural sector is uniquely determined via (14), which I denote \bar{k}^S . The profit rate from using one unit of capital in the agricultural sector is given by

$$r^S = \theta g'(\bar{k}^S), \quad (15)$$

where θ is the terms of trade; that is, the relative price of Southern export (agriculture) in terms of manufactures. This equation links the terms of trade to Southern growth. With k^S uniquely pinned down, at \bar{k}^S , it follows that the rate of growth of capital in the South equals the rate of employment expansion in the Southern modern agricultural sector; that is:

$$\frac{\dot{K}^S}{K^S} = \frac{\dot{N}^S}{N^S}.$$

The rate of growth of capital in the South is, in turn, dependent upon the savings of Southern capitalists, which, following Findlay (1980), is given by $s^S r^S K^S$, where s^S is the savings propensity of Southern capitalists. Hence $\dot{K}^S / K^S = s^S \theta g'(\bar{k}^S)$.

International Trade between North and South

The total import by the North is given by $M^N = m^N(\theta, E^N) L^N \equiv m^N(\theta, E^N)$ with normalization. Northern import of the agricultural good is negatively related to the relative price, θ , and positively related to total expenditure. In fact, with Cobb–Douglas

specification of Northern utility, $\partial m^N / \partial E^N = 1 - \beta$. The Southern import of the manufactured good is

$$M^S \equiv m_C^S \left(\frac{1}{\theta}, \bar{v}^S + (1 - s^S) g'(\bar{k}^S) \bar{k}^S \right) N^S + s^S \theta g'(\bar{k}^S) \bar{k}^S N^S, \quad (16)$$

where m_C^S is the import demand per Southern worker for the purpose of consumption. The second term on the right-hand side of (16) is investment demand by Southern capitalists.

The international trade balance condition is

$$\theta m^N = \left[m_C^S \left(\frac{1}{\theta}, \bar{v}^S + (1 - s^S) g'(\bar{k}^S) \bar{k}^S \right) + s^S \theta g'(\bar{k}^S) \bar{k}^S \right] N^S. \quad (17)$$

Dividing both sides of (17) by Λ^N , and defining \tilde{m}^N as the import function of the North per augmented worker—that is, $M^N / \Lambda^N = \tilde{m}^N(\theta, e^N)$, where $e^N \equiv E^N / \Lambda^N$ —and further letting $\gamma \equiv N^S / \Lambda^N$, the trade balance condition can be expressed as

$$\theta \tilde{m}^N(\theta, e^N) = \left[m_C^S \left(\frac{1}{\theta}, \bar{v}^S + (1 - s^S) g'(\bar{k}^S) \bar{k}^S \right) + s^S \theta g'(\bar{k}^S) \bar{k}^S \right] \gamma. \quad (18)$$

We can differentiate (18) to obtain

$$\begin{aligned} \frac{\partial \theta}{\partial e^N} &= \frac{-\theta [\partial \tilde{m}^N / \partial e^N]}{\Omega}, \\ \frac{\partial \theta}{\partial \gamma} &= \frac{m_C^S + s^S \theta \bar{k}^S g'}{\Omega}, \end{aligned}$$

where

$$\Omega \equiv \frac{m_C^S \gamma}{\theta} \left[1 - \chi^S - \frac{\tilde{m}^N \theta}{m_C^S \gamma} \chi^N \right].$$

Here, χ^N is the Northern elasticity of import demand and χ^S is the Southern elasticity of import demand. Under the assumption that $1 - \chi^S - (\tilde{m}^N \theta / m_C^S \gamma) \chi^N < 0$, our corresponding Marshall–Lerner condition in the context of this model, it is the case that θ is a positive function of e^N but a negative function of γ ; that is:

$$\theta = \theta(e^N, \gamma), \quad \theta_{e^N} > 0, \quad \theta_\gamma < 0. \quad (19)$$

Noting that e^N is a constant along a balanced growth path, I focus on the evolution of γ and ask whether the South will converge to the balanced growth path of the North. When the South is also growing at the Northern balanced growth rate, I shall describe the world economy as being on a global balanced growth path. Since N^S grows at the rate of growth of K^S , given constant returns to scale and the rigid Southern real wage, the evolution of γ is

$$\dot{\gamma} = [s^S \theta g'(\bar{k}^S) - \lambda^N] \gamma, \quad (20)$$

where we note that θ is a negative function of γ as shown in (19). We can readily check that the dynamic system is stable and that γ converges to the unique long-run value denoted γ_{LR} , which satisfies the condition

$$s^S \theta(\gamma_{LR}) g'(\bar{k}^S) = \lambda^N. \quad (21)$$

When $\gamma < \gamma_{LR}$, the Southern economy grows faster than the North. This turns the terms of trade against the South, which brings the Southern economy's growth rate to be equal to the Northern growth rate. Along a global balanced growth path, the employment in the South must grow at the rate of Northern growth; that is:

$$\frac{\dot{N}^S}{N^S} = \frac{\dot{M}^N}{M^N} = \frac{\dot{E}^N}{E^N} = \lambda^N. \quad (22)$$

Since, along a global balanced growth path:

$$\lambda^N = \theta s^S g'(\bar{k}^S), \quad (23)$$

we can use (12) in (23) to obtain an expression for the world terms of trade:

$$\theta = \frac{[F_1(a, \varepsilon[1 - U^N]) - \rho] - \mu[\mu + \rho] \left[\frac{a}{F(a, \varepsilon[1 - U^N]) - \lambda^N a} \right]}{s^S g'(\bar{k}^S)}. \quad (24)$$

Equation (24) is an important expression that gives the fundamental determinants of the terms of trade. Whereas in the Findlay (1980) model where the numerator of (24) is replaced by the exogenously given rate of growth of the effective labor force, our model provides a richer set of determinants of the international terms of trade. In particular, parameters reflecting individual preferences, such as the subjective rate of time preference, as well as policy parameters, such as social unemployment insurance, payroll taxation, and debt policy, through affecting the equilibrium rate of unemployment, influence the terms of trade.

3. Analysis of Economic Shocks

The three developments that are thought to have been an important feature of the OECD countries in the past two decades are the rise of public debt relative to GDP, the growth in social insurance schemes, and the rise in payroll taxation (Alogoskoufis and van der Ploeg, 1993; Layard et al., 1991; Phelps, 1994). We study here the influence on the world economy of introducing payroll taxes to finance given levels of a helicopter drop of public debt as well as introduction of unemployment benefits, all measured in technical efficiency units. The government budget constraint is

$$\tau^N = (r^N - \lambda^N) d^N + U^N b^N. \quad (25)$$

Note that we shall consider small exogenous increases of d^N and b^N , financed, via the government budget constraint, by an endogenous increase in the payroll tax given in (25).

To study the effect of these policy shocks, we need to redefine the nonwage income to take-home wage ratio. It is now given by

$$\begin{aligned} \frac{y^{wN}}{v_h^N} &\equiv \frac{F_1(a, \varepsilon[1 - U^N])a}{\varepsilon F_2(a, \varepsilon[1 - U^N]) - \tau^N} + \frac{\mu a}{\varepsilon F_2(a, \varepsilon[1 - U^N]) - \tau^N} \\ &\quad + \frac{(r^N + \mu)d^N}{\varepsilon F_2(a, \varepsilon[1 - U^N]) - \tau^N} + \frac{U^N b^N}{\varepsilon F_2(a, \varepsilon[1 - U^N]) - \tau^N}, \end{aligned} \quad (26)$$

where $\tau^N \equiv \Upsilon^N/\Lambda^N$, and v_h^N , the take-home wage, is related to the real wage faced by the firm, v_f^N , by $v_h^N \equiv v_f^N - \Upsilon^N$, Υ^N being the specific payroll tax.

Let us explore the dependence of y^{wN}/v_h^N on d^N , b^N , and τ^N around an initial equilibrium with zero debt, unemployment benefits, and payroll taxes. Straightforward partial differentiation of (26) gives the following results:

$$\frac{\partial[y^{wN}/v_h^N]}{\partial d^N} = \frac{r^N + \mu}{A} > 0; \quad (27)$$

$$\frac{\partial[y^{wN}/v_h^N]}{\partial b^N} = \frac{U^N}{A} > 0; \quad (28)$$

$$\frac{\partial[y^{wN}/v_h^N]}{\partial \tau^N} = \frac{(y^{wN}/v_h^N)}{A} > 0, \quad (29)$$

where $A \equiv \varepsilon[1 + (y^{wN}/v_h^N)(\varepsilon_2/\varepsilon)]F_2 + \varepsilon[1 - U^N][y^{wN}/v_h^N]\varepsilon_2 F_{22} - a[1 - U^N]\varepsilon_2 F_{12} > 0$. We make use here of the fact, shown earlier, that around an equilibrium, $0 < -(y^{wN}/v_h^N)(\varepsilon_2/\varepsilon) < 1$, making explicit that the effort function depends on the nonwage income relative to the take-home wage, y^{wN}/v_h^N . Also, $\varepsilon_2 < 0$, $F_{22} < 0$, and $F_{12} > 0$. Note also that

$$\frac{\partial[y^{wN}/v_h^N]}{\partial[1 - U^N]} = \frac{\varepsilon[1 + (1 - U^N)(\varepsilon_1/\varepsilon)][aF_{12} - (y^{wN}/v_h^N)\varepsilon F_{22}] - (y^{wN}/v_h^N)\varepsilon_1 F_2}{A} > 0, \quad (30)$$

where we use a result obtained earlier that, around an equilibrium, $0 < -(1 - U^N)(\varepsilon_1/\varepsilon) < 1$.

To see how the equilibrium rate of unemployment depends on the two policy parameters, d^N and b^N , and the implied increase in τ^N required to finance the debt and unemployment benefits given in (25), we use the generalized Solow elasticity condition in (9), making explicit that the effort function depends on the nonwage income relative to the take-home wage, y^{wN}/v_h^N . Differentiating through (9), and using (26) to (30), we obtain

$$\frac{\partial[1 - U^N]}{\partial d^N} = \frac{-[(1 - U^N)\varepsilon_{12} + 2\varepsilon_2 + (y^{wN}/v_h^N)\varepsilon_{22}]\frac{\partial(y^{wN}/v_h^N)}{\partial d^N}}{\Delta} < 0; \quad (31)$$

$$\frac{\partial[1 - U^N]}{\partial b^N} = \frac{-[(1 - U^N)\varepsilon_{12} + 2\varepsilon_2 + (y^{wN}/v_h^N)\varepsilon_{22}]\frac{\partial(y^{wN}/v_h^N)}{\partial b^N}}{\Delta} < 0; \quad (32)$$

$$\frac{\partial[1 - U^N]}{\partial \tau^N} = \frac{-[(1 - U^N)\varepsilon_{12} + 2\varepsilon_2 + (y^{wN}/v_h^N)\varepsilon_{22}]\frac{\partial(y^{wN}/v_h^N)}{\partial \tau^N}}{\Delta} < 0, \quad (33)$$

where

$$\Delta \equiv [(1 - U^N)\varepsilon_{11} + 2\varepsilon_1 + (y^{wN}/v_h^N)\varepsilon_{21}] + [(1 - U^N)\varepsilon_{12} + 2\varepsilon_2 + (y^{wN}/v_h^N)\varepsilon_{22}]\frac{\partial[y^{wN}/v_h^N]}{\partial[1 - U^N]} < 0.$$

Hence we arrive at the following important result:

$$1 - U^N = \phi(d^N, b^N), \quad (34)$$

with $\phi_{d^N} < 0$ and $\phi_{b^N} < 0$, where it is understood that the employment rate depends negatively on d^N and b^N both directly via (31) and (32) as well as indirectly via the required increase in τ^N via (33) necessitated by the budget constraint in (25). In other words, we leave out the explicit negative dependence of the employment rate on the payroll tax since, via the government budget constraint, the tax depends endogenously on d^N and b^N .

What is the intuition underlying the result that such a policy experiment contracts equilibrium employment? One way of thinking about the result is in terms of a Marshallian diagram in the $(1 - U^N, v_h^N/\Lambda^N)$ plane, depicting a demand wage schedule and an incentive-wage schedule. The former is downward-sloping because a rise in the employment rate increases the chances of landing a job should one be thrown into the unemployment pool, consequently weakening job attachment and raising the amount of shirking. This has the effect of reducing worker productivity; accordingly, the wage that firms can afford to pay declines with a rise in the rate of employment. The latter is upward-sloping because, as the labor market tightens, each additional penny paid to a firm's workforce has a greater impact on reducing shirking, thus raising the marginal benefit obtained from paying each worker an additional penny. Hence, the incentive wage rises as the rate of employment rises. The intersection of these two schedules gives the equilibrium rate of (un)employment for given policy parameters. If we start from an initial situation with zero debt, unemployment benefit and payroll tax, the introduction of a payroll tax, taken alone, has the effect of driving a wedge between the demand wage and the supply wage. A higher rate of equilibrium unemployment is required to reconcile the two curves. In the same plane, it is clear that an increase in public debt and in unemployment benefits raise the amount of fallback income available to the worker in the event that he loses his job. This tends to weaken his job attachment, which leads to a decline in the demand wage and a rise in the incentive wage at each rate of employment. The final equilibrium corresponds to increased joblessness.

Recall that $1 - U^N$ is ultimately related to d^N and b^N via $\phi(d^N, b^N)$, $\phi_{d^N} < 0$, $\phi_{b^N} < 0$. The long-run growth rate in the North is now expressible as

$$\lambda^N = [F_1(a, \varepsilon\phi(d^N, b^N)) - \rho] - \mu[\mu + \rho] \left[\frac{a + d^N}{F(a, \varepsilon\phi(d^N, b^N)) - \lambda^N a} \right]. \quad (35)$$

Under the condition that the direct effect of a rise in equilibrium unemployment dominates the salutary effect that higher unemployment has on work incentives, a condition represented by $J \equiv \varepsilon + (1 - U^N)\{\varepsilon_1 + \varepsilon_2[\partial(y^{wN}/v_h^N)/\partial(1 - U^N)]\} > 0$, straightforward differentiation through (35) around an initial equilibrium of zero public debt, unemployment benefits, and payroll taxation shows that a rise in d^N and b^N , and the implied rise in τ^N , increase joblessness and result in slower growth:

$$\frac{\partial \lambda^N}{\partial d^N} = \frac{\left[J\phi_{d^N} + \phi\varepsilon_2 \frac{\partial(y^{wN}/v_h^N)}{\partial d^N} \right] \left[F_{12} + \frac{\mu[\mu + \rho]aF_2}{(F - \lambda^N a)^2} \right] - \frac{\mu[\mu + \rho]}{(F - \lambda^N a)}}{1 + \frac{\mu[\mu + \rho]a^2}{(F - \lambda^N a)^2}} < 0, \quad (36)$$

$$\frac{\partial \lambda^N}{\partial b^N} = \frac{\left[J\phi_{b^N} + \phi\varepsilon_2 \frac{\partial(y^{wN}/v_h^N)}{\partial b^N} \right] \left[F_{12} + \frac{\mu[\mu + \rho]aF_2}{(F - \lambda^N a)^2} \right]}{1 + \frac{\mu[\mu + \rho]a^2}{(F - \lambda^N a)^2}} < 0. \quad (37)$$

The essential mechanism that is at work in this model is the way that increased public debt holding, more generous unemployment benefits, and the implied increased payroll taxes (all measured relative to productivity levels) cause the fallback income to rise relative to wage earnings at each level of employment. This leads to poorer job attachments and an increased propensity to shirk. As a result, the equilibrium rate of unemployment rises as the wage that firms can afford to pay declines while the incentive cost-minimizing wage must rise. Equilibrium is restored necessarily at a higher rate of unemployment. As more people are thrown out of jobs, capital has fewer effective units of the cooperating factor to work with, which causes capital productivity to decline—though this effect is attenuated somewhat as the workers who are fortunate enough to keep their jobs value their work more and slacken less. (It seems highly unlikely that when over 20 million people in Europe are thrown out of their jobs, the disciplining effect of unemployment would be so strong as to cause the increased effort of the remaining employed workforce to more than compensate for the loss of manpower due to the loss of jobs.) As the marginal productivity of capital suffers, the pace of capital accumulation also slows down. Through a learning-by-doing link, the rate of productivity growth also declines. How does this affect the South?

The answer is that the slowdown in Northern growth turns the terms of trade against the South on the new global balanced growth path. This can be seen from the fact that, along a global balanced growth path, $\theta = \lambda^N / (s^S g'(\bar{k}^S))$, where λ^N is determined entirely by Northern parameters. Since θ is a function of e^N and γ , whether γ_{LR} rises or falls depends on what happens to e^N , which is ambiguous since $e^N = F(a, \varepsilon[1 - U^N]) - \lambda^N a$. (The policy shocks raise equilibrium unemployment, and under the proviso that the direct effect of a lower $1 - U^N$ on $F(\cdot)$ dominates, $F(\cdot)$ falls as λ^N falls.) In the convenient case where e^N remains unchanged, λ_{LR} is unambiguously raised. In this case, it is clear that the growth rate of the South steadily falls and converges to the new lower balanced growth rate of the North. This is because the steady deterioration of the Southern terms of trade translates into a decline in the profit rate in the South and a consequent slowdown in the Southern pace of capital accumulation. Since the optimal capital-labor ratio in the South is pinned down by the rigid real wage, this means that the pace of employment expansion in the South is also reduced as a result of increased public sector debt, generous unemployment benefits, and the implied higher payroll taxes in the North.

4. Conclusion

In recent years, some economists have argued for policies that seek to reverse the disincentives toward work in the OECD. Orszag and Snower (1997) propose the replacement of current unemployment benefit systems by unemployment support accounts. In the latter scheme, employed people would be required to make ongoing contributions to their unemployment support accounts, and the balances in these accounts

would be made available to them during periods of unemployment. Because of the incentive effects in moving from the current unemployment benefit systems to the unemployment support accounts, this shift in policy has the potential to expand employment and lower the equilibrium rate of unemployment.

Phelps (1997) has championed the implementation of low-wage employment subsidies to counteract the negative effects of payroll taxes, which I have shown drive up the equilibrium rate of unemployment.

From the perspective of the present paper, these labor-market policy reforms lead not only to a decline in the equilibrium rate of unemployment in the North (a level effect) but also to a rise in the growth rate of the North (a growth effect), which leads to a higher growth rate in the South via a long-run terms-of-trade improvement. It is also clear that efforts in the North to reduce the debt to GDP ratio act to stimulate growth not only by curtailing consumption but also by lowering equilibrium unemployment through increasing the returns to work relative to workers' nonwage incomes.

Some limitations of the present model can be highlighted in concluding this paper. The persistently high rate of unemployment, especially in Europe, has occurred along with slow growth. Although the model captures these features and shows how the South is affected by sluggish economic performance in the North, in reality, the growth and employment experiences of countries in the OECD have been varied. For instance, America experienced fairly low unemployment rates in the 1980s compared with western Europe. To capture this phenomenon, we would need a three-region world economy. Also, as noted by Findlay (1980), the North-South model with a labor-surplus economy gives only a "quasi" steady-state balanced-growth path of this world economy. Presumably with the engine of growth running, the labor surplus in the South would be drained and the South turn into a symmetrical modern economy. Another item for future research is to incorporate international capital mobility into the model.

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